PHASE THREE: CONTROL
MOLECULE RACES

Mission: Can changing temperature make molecules move?

Age: 5+
Materials: $12

Time: 30 min
(Set-up: 5 min Activity: 20 min Clean-up: 5 min)

What you need:

Materials:
- 2 small covered boxes of the same size (a shoebox or something similar works well)
- 2 round balloons
- 2 cotton balls
- Mint flavor extract (or vanilla, almond, etc.)

Equipment:
- 1/4 tsp. measuring spoon
- Medicine dropper (optional)
- Hand balloon pump (optional)

What to do:

1. With the help of a grown-up, add about a quarter teaspoon of mint flavoring to each cotton ball using a measuring spoon or medicine dropper.
   Put one cotton ball inside each balloon, being careful not to get any extract on the outside of the balloon.

2. Blow up the balloons (using a pump makes it easier) just enough so that they still fit in the boxes and are the same size, then tie them off. Place one balloon inside each box and replace the cover.

3. Place one box somewhere warm and the other box somewhere cool. For example, go outside and try a sunny spot vs. a shady spot, or out on a counter vs. in the refrigerator. Wait 5-10 minutes, then collect the two boxes.

4. Open up each box separately and smell inside. Which box has a stronger scent? Why do you think there was a difference between the warmer and cooler boxes?

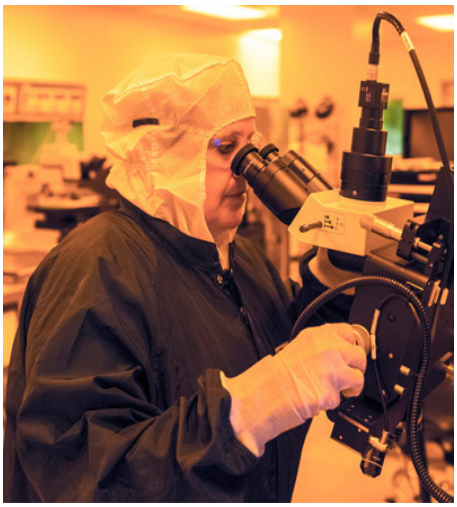
Clean-up:

Throw balloons with cotton balls in the trash. Recycle or reuse covered boxes for another purpose.

What's Happening?

You probably noticed that the scent was stronger in the box that was in the warm location. The temperature of a system affects how fast the molecules within the system are moving. In the warm location, the individual mint extract molecules evaporate from liquid to gas at a faster rate than they do in the cold location. Inside the warm box, there are more mint molecules in the gas phase and they're moving faster than the molecules in the cold box. The faster gas molecules are able to move, or diffuse, through the air and through the balloon into the box more quickly, giving a stronger mint smell.

So What?



In this activity, we discovered that it is possible to control the movement of gas molecules by controlling the temperature of their environment. Scientists also use temperature to manipulate materials at the atomic level, like super heating metal into a gas so it can be deposited on top of another material. These processes are used to invent new combinations of materials that don't exist in nature.

However, the tools that scientists use in the lab are really complicated, and sometimes involve dangerous materials. These tools must be used in a controlled environment, such as a clean room, where the air is carefully filtered. Since scientists can't safely use most of their senses (like sense of smell) to determine the success of the process, they have to use other equipment such as microscopes to analyze their results.

NGSS Alignment of Molecule Races Activity

The information below may not include every area that this activity can be linked to NGSS concepts

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- Middle School
  - ◇ Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.
  - ◇ In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative in locations.

Performance Expectations

MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Crosscutting Concepts

Cause and Effect

- Grade 3-5
  - ◇ Cause and effect relationships are routinely identified, tested, and used to explain change.
- Middle School
  - ◇ Cause and effect relationships may be used to predict phenomena in natural or designed systems.
  - ◇ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Engineering and Science Practices

Developing and Using Models

- Grade 3-5
  - ◇ Develop and/or use models to describe and/or predict phenomena.
  - ◇ Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.
- Middle School
  - ◇ Develop or modify a model-based on evidence- to match what happens if a variable or component of a system is changed.
  - ◇ Develop and/or use a model to predict and/or describe phenomena.
  - ◇ Develop a model to describe unobservable mechanisms.